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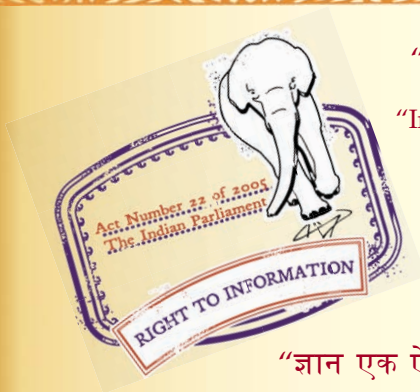
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“Step Out From the Old to the New”

IS 12021 (1987): Control Transformers for Switchgear and Controlgear for Voltages not Exceeding 1 000 V ac [ETD 7: Low Voltage Switchgear and Controlgear]



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Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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REAFFIRMED

2005

IS : 12021 - 1987
(Reaffirmed 2005)

Indian Standard
SPECIFICATION FOR
CONTROL TRANSFORMERS FOR SWITCHGEAR
AND CONTROLGEAR FOR VOLTAGES
NOT EXCEEDING 1 000 V ac

Second Reprint MAY 2009
(Including Amendment No. 1 & 2)

UDC 621.314.222.6

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

**SPECIFICATION FOR
CONTROL TRANSFORMERS FOR SWITCHGEAR
AND CONTROLGEAR FOR VOLTAGES
NOT EXCEEDING 1 000 V ac**

Low Voltage Switchgear and Controlgear Sectional Committee, ETDC 57

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(*Continued on page 2*)

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IS : 12021 - 1987

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AMENDMENT NO. 1 JULY 1997
TO
IS 12021 : 1987 SPECIFICATION FOR CONTROL
TRANSFORMERS FOR SWITCHGEAR AND
CONTROLGEAR FOR VOLTAGES NOT EXCEEDING
1 000 V ac

(*Page 3, clause 0.3, line 2*) — Substitute 'IS 13947 (Part 1) : 1993 Low voltage switchgear and controlgear : Part 1 General rules' for 'IS : 4237 - 1982*'.
(*Page 3, footnote with '*' mark*) — Delete.

(*Page 4, clause 2.0, line 2*) — Substitute 'IS : 1885 (Part 38) : 1993/IEC Pub 50 - 421 (1990) Electrotechnical vocabulary : Part 38 Transformers' for 'IS : 1885 (Part 38) - 1977§§'.
(*Page 4, footnote with '§§' mark*) — Delete.

(*Page 5, clause 2.5, Note*) — Delete.

(*Page 5, footnote with '*' mark*) — Delete.

(*Page 5, footnote with '*' mark*) — Delete.
(*Page 6, clause 4.3.1, line 3*) — Substitute 'IS 1076 (Part 1) : 1985/ISO 3-1973 Preferred numbers : Part 1 Series of preferred numbers' for 'IS : 1076 - 1967*'.
(*Page 6, footnote with '*' mark*) — Delete.

(*Page 6, footnote with '*' mark*) — Delete.
(*Page 7, clause 5.2, line 2*) — Substitute 'IS 3156 (Part 1) : 1992 Voltage transformers : Part 1 General requirements' for 'IS : 3156 (Part 1) - 1978*'.
(*Page 7, footnote with '*' mark*) — Delete.

(*Page 7, footnote with '*' mark*) — Delete.

(*Page 9, clause 7*) — Substitute 'IS 13947 (PART 1) : 1993 LOW VOLTAGE SWITCHGEAR AND CONTROLGEAR: PART 1 GENERAL RULES' for 'IS : 4237 - 1982†'.
(*Page 9, footnote with '†' mark*) — Delete.

(*Page 9, footnote with '†' mark*) — Delete.

(ET 07)

AMENDMENT NO. 2 DECEMBER 2006
TO
IS 12021 : 1987 SPECIFICATION FOR CONTROL
TRANSFORMERS FOR SWITCHGEAR AND
CONTROLGEAR FOR VOLTAGES NOT
EXCEEDING 1 000 V ac

(Page 20, clause **A-4.3.2**, lines *first, second and third*) — Substitute the following for the existing:

$$\begin{aligned} & \text{“Total equipment VA burden} \\ & = \sqrt{(W)^2 + (VAR)^2} \\ & = \sqrt{(909)^2 + (1\,765)^2} \text{”} \end{aligned}$$

Indian Standard

SPECIFICATION FOR CONTROL TRANSFORMERS FOR SWITCHGEAR AND CONTROLGEAR FOR VOLTAGES NOT EXCEEDING 1 000 V ac

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 23 February 1987, after the draft finalized by the Low Voltage Switchgear and Controlgear Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This specification is intended to fulfil the need for preparing a standard for control transformers for ac motor starter circuit feeders specifically intended to provide control supply voltage for control circuit of the starter, that is starter coils, timers, indicating lamps etc. This application is distinct from other applications for transformers such as for instrumentation and protection.

0.3 The general requirements for switchgear and controlgear are covered in IS : 4237-1982*. This standard, for the purposes of clarity shall be read in conjunction with the same.

0.4 Guidelines for calculating the VA burden of control-circuits in switchgear and controlgear applications are given in Appendix A.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the requirements of the transformers used in switchgear and controlgear to supply power to control or auxiliary equipment not intended for direct connection to the main circuit.

*General requirements for switchgear and controlgear for voltages not exceeding 1 000 V ac or 1 200 V dc (*first revision*).

†Rules for rounding off numerical values (*revised*).

1.2 This standard does not cover transformers such as:

- a) Power transformers (*see* IS : 2026)*;
- b) Distribution transformers (*see* IS : 1180)†;
- c) Instrument transformers (*see* IS : 2705‡ and IS : 3156§);
- d) Welding transformers (*see* IS : 1851-1975|| and IS : 4804 (Part 1)-1968)¶;
- e) Mining transformers (*see* IS : 2772)**;
- f) Earthing transformers (*see* IS : 3151-1982)††;
- h) Reactors (*see* IS : 5553)‡‡;
- g) Starting transformers;
- j) Testing transformers;
- k) Lighting transformers;
- m) Furnace transformers;
- n) Traction transformers for use on rolling stock;
- p) Transformers for use with electronic equipment;
- q) Transformers for use with medical equipment; and
- r) Transformers for space heating and winding heating.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions, in addition to those given in IS : 1885 (Part 38)-1977§§ shall apply.

2.1 **Control Transformer** -- A transformer which supplies power to control and/or auxiliary equipment not intended for direct connection to the main circuit.

2.2 **Control/Auxiliary Circuit** — The external circuit connected to the terminals of the secondary winding of the control transformer.

*Power transformers (Part 1 to 4).

†Outdoor type three phase distribution transformers up to and including 100 kVA, 11 kV (*revised*).

‡Current transformers.

§Voltage transformers.

||Single operator type arc welding transformers (*second revision*).

¶Resistance welding equipment : Part 1 Single phase transformers.

**Non-flameproof mining transformers for use below ground: Part 1 Oil immersed type.

††Earthing transformers (*first revision*).

‡‡Reactors (Part 1 to 3).

§§Electrotechnical vocabulary: Part 38 Transformers (*first revision*).

2.3 Rated Burden — The maximum sustained burden including the lead burden on which the performance of the control transformer is based.

2.4 Rated Short Time Burden — The value of the control circuit burden including the lead burden which occurs for specified time on which the performance of the control transformer is also based. Unless specified otherwise the burden shall be 8 times the rated burden at 0.5 pf.

2.5 Rated Secondary Voltage — Rated secondary voltage is the voltage appearing across the secondary winding when the rated primary voltage is applied across the primary winding with the rated burden connected across the secondary winding.

NOTE — Definition for rated secondary voltage as given in 2.4.6 of IS : 1885 (Part 38)-1977* is not applicable for the purposes of this standard.

2.6 Rated VA Output — The output in VA which the transformer is capable of delivering continuously when the rated primary voltage applied across the primary winding terminals and the rated burden connected across the secondary winding terminals.

3. CLASSIFICATIONS

3.1 Control transformers are classified based on application as follows:

- a) Feeder control transformer (for individual functional unit), and
- b) Group control transformer (for more than one functional unit).

4. CHARACTERISTICS

4.1 Rated Voltages

4.1.1 Preferred Rated Primary Voltage — The preferred rated primary voltages shall be 240 V and 415 V.

4.1.2 Preferred Rated Secondary Voltage — The preferred secondary voltage shall be 24, 48, 110 and 240 V.

4.1.3 Secondary Terminal Voltage at Rated Short-time Burden — The voltage across the secondary terminals when the rated primary voltage is applied across the primary winding terminals and the secondary winding connected to the rated short time burden shall not be less than 95 percent of the rated secondary voltage.

4.1.4 Secondary Terminal Voltage at Open Circuit — The secondary terminal voltage at open circuit shall not exceed 105 percent of the rated secondary voltage when the rated primary voltage is applied across the terminals of the primary winding.

*Electrotechnical vocabulary: Part 38 Transformers (first revision).

4.1.5 Rated Insulation Voltage — Rated insulation voltage is the value of voltage to which dielectric tests, clearance and creepage distances are referred.

The maximum rated primary voltage shall not exceed the rated insulation voltage.

4.1.6 Voltage Tappings — Unless specifically requiredappings shall not be provided. Tapping of ± 5 percent may, however, be provided on primary winding if required. Requirements of taps on secondary winding are not covered in the standard.

NOTE — Before deciding on requirements of taps, following aspects need consideration:

- a) Practicability of changing taps of transformers at the same time depending on system voltage variations.
- b) Necessity and feasibility of plant shut down to carry out the tap changing.
- c) If wrong taps are retained, problems of higher magnetising current. It is to be noted that the magnetising currents may reach a value as high as full load current on control transformers especially on lower ratings for switchgear and controlgear.
- d) Burnout of coils, failure of indicating lamps etc due to over voltage and chattering and burnout of contactor coils due to lower voltages.

4.2 Frequency

4.2.1 Rated Frequency — Unless otherwise specified, the rated frequency shall be 50 Hz.

4.3 VA Output

4.3.1 Preferred Values — Preferred values of VA output shall be chosen from R10 series such as 50, 63, 80, 100, 125, 160, 200, 250, 315, 400, 500 (see IS : 1076-1967*).

4.3.2 Rated Short Time VA Output — The control transformer shall be capable of delivering power to the rated short time burden at 95 percent of the rated secondary voltage. The burden is imposed at the rate of 30 times per hour with equally spaced intervals the duration of each occurrence being not more than 50 ms (typically equivalent of contactor pick up time).

5. MARKING

5.1 Control transformer shall be marked indelibly with the following data. The marking shall be on the transformer name-plate permanently attached

*Preferred numbers (first revision).

to the equipment and shall be located in a place where it is visible and legible after the transformer is installed.

- a) Manufacturer's name or trade mark,
- b) Type designation or serial number,
- c) Year of manufacture,
- d) Country of origin,
- e) Number of this standard (Ref IS :),
- f) Rated primary and secondary voltages,
- g) Rated output and rated short time output in VA,
- h) Rated frequency,
- j) Class of insulation.

Refer Appendix B for typical name plate.

5.1.1 If the available space is insufficient to carry all the above data, the equipment shall carry at least the information at (a) and (b) permitting the complete data to be obtained from the manufacturer.

5.2 Terminal Markings — Terminal markings, tapings and connections shall be in accordance with Fig. 2, IS : 3156 (Part 1)-1978*. Typical terminal markings are shown below.

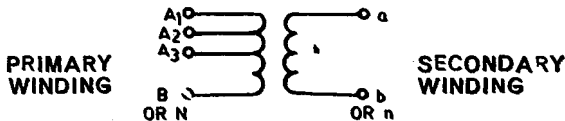


FIG. 1 TERMINAL MARKINGS FOR A CONTROL TRANSFORMER

5.3 The control transformer may also be marked with the Standard Mark.

NOTE — The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions, under which a licence for the use of the Standard Mark may be granted to manufacturers or producers, may be obtained from the Bureau of Indian Standards.

*Voltage transformers: Part 1 General requirements (*first revision*).

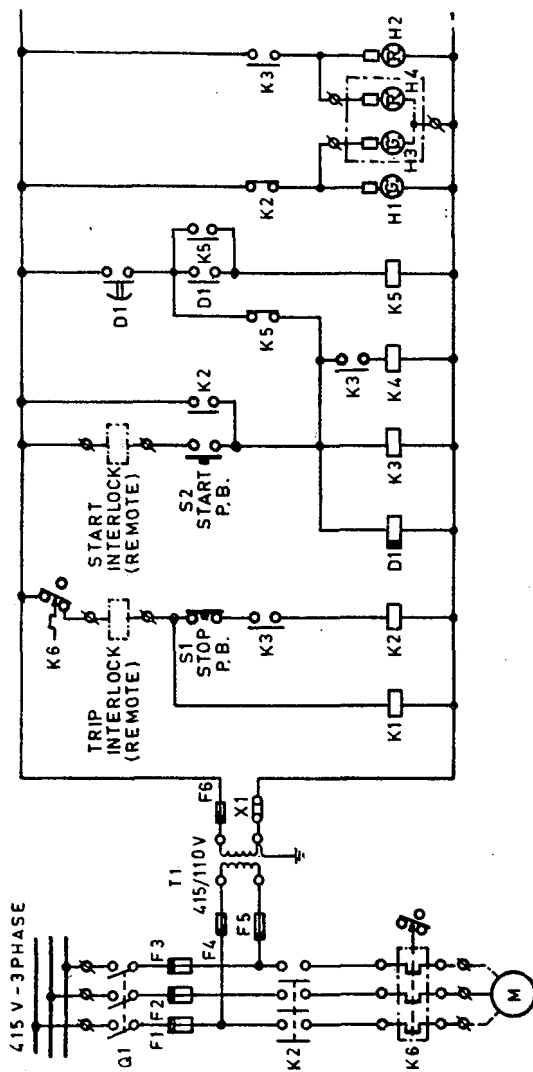


Fig. 2 A TYPICAL DOL MOTOR STARTER SCHEME

6. STANDARD SERVICE CONDITIONS

6.1 Standard service conditions shall be as per IS : 10580-1983*, except that the reference ambient temperature shall be 50°C.

NOTE — A higher reference ambient temperature is recommended for design purposes on account of the fact that control transformers are mounted in enclosures with switchgear and controlgear assemblies.

7. STANDARD CONDITIONS FOR CONSTRUCTION (ALSO see IS : 4237-1982†)

7.1 General — The transformer shall be single phase, two winding, natural air cooled and suitable for mounting within enclosure with switchgear and controlgear assemblies.

The windings shall be of copper. Insulating materials used shall be class E unless otherwise specified.

NOTE — Due consideration should be given to possible higher temperature of the winding and its possible effects on adjacent equipment while specifying insulating materials of class B and higher.

7.2 Terminals

7.2.1 The terminals shall be of substantial mechanical construction and shall provide adequate electrical contact for appropriate cable used. Minimum size of conductor shall be 2.5 mm². Use of aluminium conductors shall be taken into account. Above 16A; stud type terminals with shrouding is preferred.

7.2.2 The terminal connections shall ensure that the necessary contact pressure is maintained sufficiently and permanently, even under vibrations and shocks.

7.2.3 Terminals shall not turn or get displaced when connections are made or removed.

7.2.4 Location of terminals shall permit easy access for wiring without affecting other connections.

7.2.5 No contact pressure shall be transmitted through insulating material other than ceramic or any other material with similar characteristics, unless there is sufficient resiliency in the metallic parts to compensate for any possible shrinkage of the insulating material.

7.2.6 Insulating materials with high comparative tracking index are preferable for terminal supports.

*Service conditions for electrical equipment.

†General requirements for switchgear and controlgear for voltages not exceeding 1 000 V ac or 1 200 V dc.

7.2.7 Conductors shall not be secured by pinching screws.

7.3 Earthing

7.3.1 The metal frame assembly of the control transformer, shall be provided with an earthing terminal. The earthing terminal shall be easily accessible. It shall be separate from mounting screws.

7.3.2 The earthing terminal shall be of adequate size and protected against corrosion and shall be mechanically clean.

7.3.3 The earthing terminal shall be identified by means of the symbol \perp marked in a legible and indelible manner on or adjacent to the terminal.

7.4 Limits of Temperature-Rise

7.4.1 The temperature-rise of the windings of control transformer shall not exceed the values listed in Table 1. The test shall be carried out in accordance with 8.4.

**TABLE 1 LIMITS OF TEMPERATURE-RISE OF WINDINGS
(MEASURED BY RESISTANCE METHOD)**

CLASS OF INSULATION	MAXIMUM VALUE OF	
	Temperature	Temperature-rise (Over a reference ambient temperature of 50°C)
(1)	(2)	(3)
E	140	90
B	150	100
F	175	125
H	200	150
C	225	175

NOTE — Also see Note under 7.1.

7.4.2 The maximum temperature of the other metallic parts (for example core, frame, etc) in contact with the insulating materials shall be limited solely by necessity of not causing any damage to the insulating materials.

7.5 Ability to Withstand Short Circuit

7.5.1 The control transformer shall be capable of withstanding without damage dynamic stresses and thermal effects of short circuit at secondary winding terminals. The test shall be carried out in accordance with 8.10.

8. TESTS

8.1 Classification of Tests

8.1.1 Type Tests — The following shall constitute type tests:

- a) Verification of terminal markings (8.2),
- b) Measurement of winding resistances (8.3),
- c) Temperature rise test (8.4),
- d) Verification of dielectric properties (8.5),
- e) Measurement of insulation resistance (8.6),
- f) Measurement of no-load current (8.7),
- g) Secondary voltage tests (8.8),
- h) Measurement of impedance voltage (8.9), and
- j) Short circuit test(8.10).

NOTE — The tests may be carried out in any order (see 8.6 and 8.10) and on any one or different samples.

8.1.2 Routine Tests — The following shall constitute the routine tests:

- a) Verification of terminal markings (8.2),
- b) Measurement of winding resistances (8.3),
- c) Dielectric test (8.11),
- d) Measurement of insulation resistance (8.6),
- e) Measurement of no-load current (8.7),
- f) Measurement of no-load secondary voltage (8.8.1), and
- g) Measurement of impedance voltage (8.9).

8.1.3 Special Test — The following test shall be carried out by mutual agreement between the purchaser and the manufacturer.

- a) Co-ordination with protecting device in primary winding circuit (8.12).

8.2 Verification of Terminal Markings — Terminal markings shall be verified in conformity to 5.2.

8.3 Measurement of Winding Resistances

8.3.1 The resistance of both windings shall be measured at room temperature across their respective terminals with direct current. Care shall be taken that during the measurement, temperature of the windings should not be affected.

For routine tests the values measured shall not exceed the values obtained for the transformer subjected to the temperature-rise test, taking into account the correction factor for difference in ambient temperature, if any.

8.4 Temperature-rise Test — Primary winding terminals shall be applied the 110 percent of the rated primary voltage at the rated frequency and the rated burden shall be connected across the secondary winding terminals. Final steady state temperature shall be measured and recorded subjected to the following:

Ambient conditions shall not be more severe than specified in 6.

The transformers shall be considered to have attained a steady state temperature when the rate of temperature-rise does not exceed 1°C per hour.

The temperature rise of the winding shall be measured by the increase in resistance method. The temperature-rise of the core, frame and other parts where accessible may be measured by thermometers or thermocouples.

Methods of temperature measurement are given in IS : 9678-1980*.

Temperature-rise shall not exceed the limits prescribed in 7.4.

8.5 Verification of Dielectric Properties — The test voltage of a value indicated in Table 2 shall be applied for 1 minute between (i) all live parts and metal frame, core and earth terminals connected together, and (ii) two windings.

TABLE 2 DIELECTRIC TEST VOLTAGE

(Clauses 8.5 and 8.11)

RATED INSULATION VOLTAGE	DIELECTRIC TEST VOLTAGE
U_i	(ac) (rms)
(1)	(2)
V	V
$U_i \leq 60$	1 000
$60 < U_i \leq 300$	2 000
$300 < U_i \leq 660$	2 500
$660 < U_i \leq 800$	3 000
$800 < U_i \leq 1\,000$	3 500

*Methods of measuring temperature-rise of electrical equipment.

The test voltage at the moment of application shall not exceed 50 per cent of its value. It shall then be increased steadily within a few seconds to its full value and maintained for 1 minute. The ac power source shall have sufficient power to maintain the test voltage irrespective of leakage currents. The test voltage shall have a practically sinusoidal wave form and frequency between 45 Hz and 65 Hz.

There shall be no puncture or flashover.

8.6 Measurement of Insulation Resistance — The insulation resistance of each winding to other winding, core, frame and earth shall be measured at 500 V dc. It shall not be less than 50 megaohms. This test shall be carried out after verification of dielectric properties (8.5) or dielectric test (8.11) as the case may be.

8.7 Measurement of No-Load Current — The no-load current in the primary winding shall be measured and recorded at the rated frequency and at:

- a) the rated voltage, and
- b) 120 percent of the rated voltage.

The secondary winding shall be left open.

The variation in the value of the current measured at 120 percent of the rated voltage shall not exceed by more than 20 percent of the declared value at that voltage.

8.8 Secondary Voltages Test

8.8.1 No Load Secondary Voltage Test — The primary winding shall be applied the rated primary voltage at the rated frequency. The secondary winding terminals shall be left open-circuited. The value of the secondary voltage reading shall be compared with the rated secondary voltage. The voltage reading shall be within the value prescribed in 4.1.4.

8.8.2 Rated Secondary Voltage Test — The primary winding shall be applied the rated primary voltage at the rated frequency. The secondary terminals shall be connected to the rated burden. The voltage at the secondary terminals shall be measured and recorded. The voltage reading shall be compared with the rated secondary voltage. The variation in the reading shall be within ± 0.5 percent of the declared value.

8.8.3 Short Time Secondary Voltage Test — The primary winding shall be applied the rated primary voltage at the rated frequency. Secondary terminals shall be connected to the rated short time burden at a specified power factor agreed to between the purchaser and the manufacturer. The

voltage reading at the secondary terminals shall be measured and recorded. The value of the voltage reading shall be compared with the rated secondary voltage.

The voltage reading shall be within the value prescribed in 4.1.3.

8.9 Measurement of Impedance Voltage — Impedance voltage shall be measured at rated frequency by applying voltage to one winding, with other winding short circuited. The measurement may be made at any current corresponding to a value between 25 percent and 100 percent of the rated output.

The measured value of this voltage shall be corrected by increasing it in the ratio of rated current to test current and shall be expressed as a percentage of the rated voltage of the corresponding winding.

For the purposes of routine tests, the corrected values shall not exceed the value obtained for the transformer subjected to the type tests.

8.10 Short Circuit Test — Prior to the short circuit test the transformer shall be subjected to the routine tests specified in 8.1.2.

At the beginning of the short circuit test the average temperature of the winding shall be below 50°C.

The primary of the control transformer shall be applied the rated primary voltage at the rated frequency. The prospective short circuit current at the point of connection to the supply terminals of the transformer shall be at least ten times the full load current at the rated output.

A protective device indicated by the purchaser shall be incorporated in the primary winding circuit. The secondary terminals shall be shorted with negligible impedance. The duration of the test shall be maximum 1 second.

The transformer shall be deemed to have withstand the short circuit test if the following conditions are satisfied:

- a) No physical deformation shall have occurred; and
- b) The transformer shall pass routine tests as specified in 8.1.2 after the test.

8.11 Dielectric Test — The test voltage of the value indicated in Table 2 shall be applied for 1 second between (i) all live parts and metal frame, core and earth terminals connected together, and (ii) two windings.

The ac power source shall have sufficient power to maintain the test voltage irrespective of leakage currents. The test voltage shall have a practically sinusoidal wave form and frequency between 45 and 65 Hz.

If the transformer has previously been subjected to a dielectric test, the test voltage shall be reduced to 85 percent of the specified test voltage. There shall be no puncture or flashover.

8.12 Co-ordination with Protective Device in the Primary Winding Circuit

8.12.1 Primary winding shall be applied 112.5 percent of the rated primary voltage at the rated frequency and the secondary winding shall be left open. The prospective short circuit current at the point of connection to the supply terminals of the transformer shall be at least ten times the full load current at the rated burden.

The primary winding circuit shall incorporate protective device specified by the purchaser and a main switch of adequate rating. The switch shall be operated to turn supply 'ON' and 'OFF' for a minimum 10 times. Interval between each cycle shall not be more than 30 seconds.

The protecting device shall not operate due to inrush current resulting from the switching operations.

8.12.2 The test shall be carried out in accordance with **8.10**. The protecting device shall operate and isolate the transformer from the supply within 1 second.

9. INFORMATION REQUIRED WITH ENQUIRY AND ORDER

9.1 The technical information that the purchaser is required to supply with the enquiry and order is given in Appendix C.

A P P E N D I X A

(*Clause 0.4*)

GUIDELINES FOR CALCULATION OF VA BURDENS OF CONTROL CIRCUITS

A-1. Burden posed by the various devices connected to the secondary of a control transformer depends on the state of operations of the equipment connected viz:

- a) Pick-up/hold on/de-energised conditions for relays/contactors; and
- b) ON/OFF conditions for indicating lamps and hooters/buzzers.

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A-2. Based on the logic of operation of the devices, the following burdens shall be computed:

- a) Maximum hold-on (continuous) VA burden of all the devices expected to operate simultaneously,
- b) Maximum short time (pick-up) VA burden of all the devices expected to operate simultaneously, and
- c) Maximum lead burden of connecting cables for above conditions [see A-2 (a) and (b)].

A-3. Summation of burdens shall be done by vectorial addition, since an algebraic addition of the burdens will generally result in a higher value than that is functionally required.

A-4. Scheme diagram for the starter is shown in Fig. 2 and control circuit equipment details are listed in Table 3.

A typical calculation of VA requirement of a control circuit for a motor starter is given in A-4.1 to A-4.4.

TABLE 3 EQUIPMENT DETAILS

Sl. No.	EQUIPMENT DESCRIPTION	BURDEN DATA FOR EACH EQUIPMENT					
		Hold on			Pick up		
		W	VA	Cos ϕ	W	VA	Cos ϕ
i)	Main switch	These equipment make no contribution to burden					
ii)	Main fuses						
iii)	Fuses for control transformer						
iv)	Link for control transformer						
v)	Thermal overload relay						
vi)	'Stop' push button						
vii)	'Start' push button						
viii)	Main contactor	45	135			1 650	0.4
ix)	Auxiliary contractors		8	0.38		65	0.69
x)	Off delay timer	10	20		55	85	
xi)	Indicating lamps	7					
xii)	Control transformer						

Particulars:

- a) System — 415 V 3 Phase, 3 Wire
- b) Control circuit voltage — 110 V
- c) Cable data:
 Cross section — 1.5 mm²
 Length of wire — 50 M
 (if burden on significant)
- d) Resistivity of wire — 12 Ω /km
 (at 50°C)

A-4.1 Individual equipment burden is generally given in terms of VA at power factor or VA and W. They are available from equipment manufacturer. Remaining parameters shall be found out by using following formulae:

$$W = VA \cos \phi$$

$$VAR = VA \sin \phi$$

$$\cos \phi = \frac{W}{VA}$$

$$\sin \phi = \sqrt{1 - \cos^2 \phi}$$

All burden parameters of the equipment are listed in Table 4.

**TABLE 4 LIST OF CONTROL CIRCUIT EQUIPMENT
BURDEN PARAMETERS**

Sl No.	EQUIPMENT DESCRIPTION	COIL DATA							
		Hold on				Pick-up			
		VA	W	VAR	cos ϕ lagging	VA	W	VAR	cos ϕ lagging
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	Main contactor	135	45	127	0.33	1 650	660	1 512	0.4
ii)	Auxiliary contactor	8	3	7.4	0.38	65	45	47	0.69
iii)	Timer	20	10	17	0.5	85	55	65	0.65
iv)	Indicating lamp	—	7	—	—	—	—	—	—

A-4.2 Selection of the operations:

- a) Maximum hold-on (continuous) VA,
- b) Maximum short-time (pick up) VA.

Following listed (a to e) are normal maximum possible operations of the control circuit. Individual equipment operation (such as, pick-up/hold on/on) is noted against each control circuit operation.

- a) Energisation of feeder by main switch
 - Auxiliary contractor (K1) — Pick-up
 - Indicating lamps (H1, H3) — 'ON'
- b) 'START' push button manual simulation
 - Status after simulation — (transient condition)
 - Auxiliary contactor (K1) — Hold on
 - Auxiliary contactors (K3, K4, K5) — Pick-up
 - Main contactor (K2) — Pick-up
 - Timer (D1) — Pick-up
 - Indicating lamps (H2, H4) — 'ON'
- c) After simulating 'START' push button—steady state condition:
 - Auxiliary contactors — Hold on
 - (K1, K3, K4, K5)
 - Main contactor (K2) — Hold on
 - Timer (D1) — Hold on
 - Indicating lamps (H2, H4) — 'ON'
- d) 'STOP' push button manual
 - Simulation/Trip by thermal overload relay (KG) trip interlock
 - Auxiliary contactors (K1, K5) — Hold on
 - Indicating lamps (H, H3) — 'ON'
- e) Auto start after resumption of control supply:
 - Auxiliary contactors — Pick-up
 - (K1, K3, K4, K5)
 - Main contactor (K2) — Pick-up
 - Timer (D1) — Pick-up
 - Indicating lamps (H2, H4) — 'ON'

From the above list it is clear that at (c) the maximum hold VA occurs and at (e) the maximum short time VA occurs.

A-4.3 Calculation of the Burden**A-4.3.1 Maximum hold-on VA burden calculations:**

$$W : 4(3) + 45 + 10 + 14 = 81 \text{ W}$$

$$\text{VAR} : 4(7.4) + 127 + 17 = 173.6 \text{ VAR}$$

Total equipment VA burden

$$\begin{aligned} &= \sqrt{(W)^2 + (\text{VAR})^2} \\ &= \sqrt{(81)^2 + (173.6)^2} \\ &= 192 \text{ VA} \end{aligned}$$

Control circuit current I

$$\begin{aligned} &= \frac{\text{VA}}{V} \\ &= \frac{192}{110} \\ &= 1.75 \text{ Amps} \end{aligned}$$

Lead resistance

$$\begin{aligned} &= 12 \times \frac{100}{1000} \\ &= 1.2 \end{aligned}$$

Lead burden (assumed purely resistive)

$$\begin{aligned} &= (I)^2 \times R \\ &= (1.75)^2 \times 1.2 \text{ W} \\ &= 3.7 \text{ W} \end{aligned}$$

Total maximum hold-on VA burden

$$\begin{aligned} &= \sqrt{(81)^2 + (3.7)^2 + (173.6)^2} \text{ VA} \\ &= 193 \text{ VA} \end{aligned}$$

Power factor ($\cos \phi$)

$$= \frac{W}{\text{VA}} = \frac{84.7}{193} = 0.44$$

A-4.3.2 Maximum Short Tie VA Burden Calculation

Calculation of the burden

$$W : 4(45) + 660 + 55 + 14 = 909 \text{ W}$$

$$\text{VAR} : 4(47) + 1512 + 65 = 1765 \text{ VAR}$$

Total equipment VA burden

$$\begin{aligned} &= (W)^2 + (\text{VAR})^2 \\ &= (909)^2 + (1\,765)^2 \\ &= 1\,985\text{ VA} \end{aligned}$$

Control circuit current I

$$\begin{aligned} &= \frac{\text{VA}}{V} \\ &= \frac{1\,985}{110} \\ &= 18\text{ Amps} \end{aligned}$$

Lead burden (assumed purely resistive)

$$\begin{aligned} &= (I)^2 \times R \quad W \\ &= (18)^2 \times 1.2 \quad W \\ &= 389 \quad W \end{aligned}$$

Total maximum short time VA burden

$$\begin{aligned} &= \sqrt{(909 + 389)^2 + (1\,765)^2} \quad \text{VA} \\ &= 2\,191 \quad \text{VA} \end{aligned}$$

Power factor ($\cos \phi$)

$$= \frac{W}{\text{VA}} = \frac{1\,298}{2\,191} = 0.59$$

A-4.4 The VA burdens thus calculated may be suitably increased to take into account any possible circuit modifications, future additions, safety margins and any other considerations. It may then be rounded off to the nearest preferred rating as prescribed in 4.3.1 and 4.3.2:

Ratings of the transformer will therefore be:

- a) Rated output : 250 VA
- b) Rated short time output : 2 500 VA
- c) Power factor at rated burden : 0.44 lagging
- d) Power factor at short time rated burden : 0.59 lagging.

APPENDIX B*(Clause 5.1)***TYPICAL NAME PLATE**

CONTROL TRANSFORMER		TYPE XX
MANUFACTURER'S NAME/TRADE MARK		
XXXXXXXXXXXXXXXXXX		XXX
COUNTRY OF ORIGIN		IS : XXXX
XXXXXXXXXXXXXXXXXX		
VA RATINGS	XXX/XXXX	
RATED VOLTAGES		
PRIMARY/SECONDARY	XXX/XX	50
INSULATION CLASS E		

Example of a typical name plate

A P P E N D I X C

(*Clause 9.1*)

INFORMATION REQUIRED WITH ENQUIRY AND ORDER

C-1. The following technical information may be supplied with enquiry and order:

- a) Rated primary and secondary voltages,
- b) Rated frequency,
- c) Rated output and rated short time output : Eg XXX/XXXX,
- d) Power factor of rated short time burden,
- e) Class of insulation if other than class E,
- f) Service condition if other than standard service conditions (*see 6*),
- g) Special features such as limiting overall dimensions, mounting position/mounting arrangement,
- h) Termination details such as conductor size, and termination with lugs or without lugs,
- j) Details of protective device for primary winding.

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Patliputra Industrial Estate, PATNA 800013	226 2808
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